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Pacific Northwest Region

ROOT DISEASE SURVEY OF THE

MISTLETOE AND SKI OVERSTORY SALE AREAS

PROSPECT RANGER DISTRICT

ROGUE RIVER NATIONAL FOREST

OREGON

ROOT DISEASE SURVEY OF THE MISTLETOE AND SKI OVERSTORY SALE AREAS, PROSPECT RANGER DISTRICT, ROGUE RIVER NATIONAL FOREST, OREGON

by

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ABSTRACT

Two proposed timber sale areas were surveyed for root diseases. Almost all of the infection and mortality were caused by *Armillaria mellea*, primarily in ponderosa pine and white fir. Some trees that probably would have died had been harvested prior to the survey. Stumps of old-growth Douglas-fir and ponderosa pine may be serving as inoculum sources to infect second-growth white fir and ponderosa pine. Management alternatives regarding root diseases are discussed.

INTRODUCTION

Root diseases cause significant damage both as mortality and growth loss in living infected trees throughout the Pacific Northwest. *Armillaria mellea* (Vahl ex Fr.) Quel., the cause of Armillaria root rot, is active in the mixed fir and pine forests in the Cascade Range of Oregon and Washington. A survey for root diseases on the Klamath Ranger District of the Winema National Forest revealed that trees representing 25% of the board-foot volume present were killed by *A. mellea* on one severely diseased unit (Filip 1977). More recently, a survey was completed in the Bybee Creek area of the Prospect Ranger District, Rogue River National Forest (Filip et al 1980). *Armillaria mellea* had killed trees representing 12% of the board foot volume during the past 20 years.

Armillaria mellea persists from one stand generation to the next in stumps and large roots of infected trees. These serve as food bases for subsequent infection of susceptible species regenerating on the site. The fungus spreads through the soil by infective structures called rhizomorphs that grow from infected roots and stumps to roots of healthy trees. The fungus also spreads from tree to tree across root contacts and grafts.

Another root disease that is frequently observed in the true fir type is annosus root rot caused by *Fomes annosus* (Fr.) Cke. This fungus spreads across root contacts as well as by airborne spores. Freshly-cut stump surfaces and wounds are common infection courts for spores. The disease causes a butt rot more commonly than tree mortality.

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Laminated root rot caused by *Phellinus weirii* (Murr.) Gilbertson, causes substantial damage in the Douglas-fir and true fir types. In one southern Oregon site of white and Douglas-fir, trees representing 33% of the board foot volume present were killed by *P. weirii* (Goheen 1980). Like *A. mellea* and *F. annosus, P. weirii* persists in stumps and roots which serve as food bases for subsequent infection of susceptible regeneration. Fungus spread is along roots and across root contacts and grafts. Spread by spores is negligible.

Prospect Ranger District personnel requested an evaluation to determine the distribution and intensity of root rot on two sale areas after Sally Cooley, a pathologist from Forest Pest Management, identified *A. mellea* on the sites during a visit on October 7, 1980.

Surveys of the Mistletoe and Ski Overstory Sale Areas were done by a Forest Pest Management pathology crew on October 28-30, 1980. The Mistletoe Sale Area is located in T. 30 S., R. 4 E., Sec. 30 and the Ski Overstory Sale Area is in T. 31 S., R. 3 E., Sec. 1 (Fig. 1).

METHODS

Approximately 200 acres were surveyed systematically using variable plots (40 BAF). The two areas were divided into 5 homogeneous blocks. Plots were located at 15-chain intervals along transects 5 chains apart across each block. In each plot, trees greater than or equal to 5.0 in. DBH were tallied by prism. Data recorded for each tree included: (1) species, (2) DBH (approximated for stumps), (3) condition (live, recently killed, snag, stub, or harvested stump), and (4) presence of root diseases.

All symptomatic (chlorotic, ragged crown, etc.) or dead trees and stumps were examined for root diseases. Two roots, one on either side of the tree or stump, were excavated for a distance of 3 feet from the root collar. Root surfaces were checked for ectotrophic mycelium of *P. weirii*. Bark was removed and roots checked for mycelial fans of *A. mellea* (Fig. 2). Finally, root wood was examined for laminated rot caused by *P. weirii*; yellow, stringy rot caused by *A. mellea*; or white, stringy rot caused by *F. annosus* (Fig. 3). No attempt was made to culture pathogens or determine presence of infection in living, nonsymptomatic trees.

In order to obtain more complete information on disease distribution, an additional set of prism plots was established along the survey lines at 5-chain intervals in Block 1, and 3 chain intervals in Blocks 2, 3, 4, and 5. If any root disease was present in the plot, DBH's were recorded for diseased trees and a basal area count was taken of the healthy trees in the plot. If root diseases were not found, no data were taken.

From the data collected at each plot, mean basal area, number of trees, and volume per acre were calculated by tree species, DBH class, and disease condition using the Region 6, V-plot computer program. Information from the plots was used to prepare root disease distribution maps.

RESULTS

Ski Overstory Sale Area

Stand Composition

White fir (*Abies concolor*) was the most common species in the two blocks surveyed. Of an average 142.3 trees per acre (T/A) greater than or equal to 5.0 in. in DBH, 73.8% were white fir, 23.8% were Douglas-fir (*Pseudotsuga menziesii*), 1.9% were western white pine (*Pinus monticola*), and 0.5% were ponderosa pine (*P. ponderosa*) (Table 1). Although white fir was the most abundant tree species, it occupied smaller diameter classes than Douglas-fir and therefore had a lower board foot volume. Of an average of 39.8 thousand board feet per acre, 73.3% were Douglas-fir, 21.7% were white fir, 3.2% were white pine and 1.8% were ponderosa pine. These board foot volumes include estimates of the harvested volume for all the species over the past 20 years. Douglas-fir was harvested most frequently with approximately 10.0 MBF/A. cut. White fir and ponderosa pine were harvested to a lesser degree with 1.6 and 0.6 MBF/A. cut, respectively. No white pine were harvested.

Mortality by Plot Basis

About 100 acres of the Ski Overstory Sale Area were surveyed with 66 variable plots (0.7 plots/acre) established. Trees on 29 plots (44%) were infected by one or more root pathogens. Figure 4 shows percent of basal area infected on each plot.

Disease Incidence-Tree Species - Size Class Relationships

Of the white fir, 15.5% T/A were dead and infected, representing 27.7% basal area (BA)/A and 29.9% BF/A (Table 1). Most of these dead trees (94.5%) were snags and stubs less than 24 in. DBH. Infected white fir occupied the smaller size classes and had not been harvested frequently in the past.

Douglas-fir was less severely affected by root rots: 15.1% T/A, 14.5% BA/A, and 13.9% BF/A were infected. Although there was some infection and mortality in the unharvested Douglas-fir, most of the infected volume (96.3%) was harvested. Some of these trees could have been infected or further colonized after harvest, since *A. mellea* can infect or further colonize stumps after the stems are cut.

All of the ponderosa pine encountered in the survey had root disease, however most of these were stumps. Some of the stumps may have been infected or further colonized after harvest. No dead white pines were encountered in the survey.

The relative frequencies of disease by size classes for all species combined are presented in Table 3. Diseased-unharvested trees tended to occupy the smaller size classes and diseased-harvested trees the larger classes.

Mortality Agents

The most common pathogen encountered during the survey was *A. mellea*. Ninety-five percent of the root-diseased T/A representing 88.3% diseased BA/A and 87.3% diseased BF/A were infected with *A. mellea* (Table 2). *Phellinus*

weirii was found in association with *A. mellea* in Douglas-fir stumps. *Fomes annosus* was found in white fir and Douglas-fir often in association with *A. mellea*. Neither *P. weirii* nor *F. annosus* were causing significant mortality. No attempts were made to determine infection by these or other pathogens in live, nonsymptomatic trees, although such infection undoubtedly does occur.

Loss Due to Root Disease

The actual loss due to root disease-caused mortality was estimated by comparing the amount of unharvested mortality to the total unharvested stands. White fir was experiencing the highest losses with 14.9% T/A, 24.2% BA/A, and 24.5% BF/A killed by root diseases. All of the unharvested ponderosa pine were killed by root diseases, but ponderosa pine was a relatively minor component of the stand. Douglas-fir experienced considerably lower losses: 8.6% T/A, 1.7% BA/A, and 0.8% BF/A. All of the Douglas-fir killed by root diseases were in trees less than 20 in. DBH, whereas healthy Douglas-fir occupied all size classes from 12 in. to 48 in. DBH. Root pathogens had killed an average of 17.7 T/A, representing 14.5 $ft.^2$/A and 2.0 MBF/A per acre of all species combined over the last 20 years.

Mistletoe Sale Area

Stand Composition

White fir was again the most common tree species in the three blocks surveyed. Of an average 209.8 T/A greater than or equal to 5.0 in. in DBH, 58.8% were white fir, 22.4% were Douglas-fir, 17.2% were ponderosa pine, and 1.6% were western white pine (Table 4). Douglas-fir again had the highest volume. Of an average 35.0 MBF/A, 51.9% were Douglas-fir, 28.7% were white fir, 18.0% were ponderosa pine, and 1.4% were white pine. These volumes include estimates of the harvested volume for all species. Approximately 6.9 MBF/A of Douglas-fir, 3.3 MBF/A of ponderosa pine, 1.1 MBF/A of white fir, and 0.2 MBF/A of white pine were harvested over the last 20 years.

Mortality by Plot Basis

Approximately 100 acres of the Mistletoe Sale Area were surveyed systematically with 54 variable plots (0.5 plots/acre). Seventeen plots (31%) contained trees infected by one or more root pathogens. Figure 5 shows the percent of basal area infected on each plot.

Mortality Agents

Armillaria mellea was the most common pathogen encountered during the survey. Ninety-three percent of the root-diseased T/A representing 88.6% diseased BA/A and 87.6% of the diseased BF/A were infected with *A. mellea* (Table 5). Other pathogens encountered were *F. annosus* and *P. weirii*. Both of these pathogens usually were found in association with *A. mellea* and were not causing significant mortality. No attempts were made to determine infection by these or other pathogens in live, nonsymptomatic trees, although such infection undoubtedly does occur.

None of the trees listed under "dead-unknown-harvested" were infected by root diseases (Table 3). Dead-unknown-unharvested trees usually were too deteriorated to determine cause of death; however, much of the white pine may have been killed by blister rust (*Cronartium ribicola*). All dead-unknown-unharvested trees were in the 8 to 12 in. diamater class (Table 6).

Disease Incidence-Tree Species-Size Class Relationships

Ponderosa pine was the most frequently infected species in the Mistletoe Sale Area. Eight percent T/A were infected representing 22.9% BA/A and 30.5% BF/A (Table 4). Most of this infected volume had been harvested already and some of these trees may have been infected after harvest. White fir was moderately infected: 1.5% T/A, 6.3% BA/A, and 9.3% BF/A. Douglas-fir had lower levels of infection: 1.3% T/A, 5.1% BA/A, and 7.0% BF/A. All of the infected Douglas-fir had been harvested and also may have been infected or further colonized after the harvest. All of the root-diseased white pine had been harvested, and colonization may have occurred after harvest. The relative frequencies of root diseases by size classes for all species combined are presented in Table 6. Diseased, unharvested trees tended to occupy the smaller size classes and dead, harvested trees the larger classes.

Loss Due to Root Disease

The actual loss due to mortality was lower for the Mistletoe Sale Area than for the Ski Overstory Sale Area. Ponderosa pine was experiencing the highest losses with 5.8% T/A, 6.3% BA/A, and 4.1% BF/A being killed by root pathogens. White fir had 1.0% T/A , 2.3% BA/A, and 2.1% BF/A killed by root pathogens. Only stumps of harvested Douglas-fir and white pine were infected by root pathogens. Root pathogens had killed an average of 3.1 T/A, representing 3.0 $ft.^2$/A, and 0.3 MBF/A of all the species combined over the past 20 years.

DISCUSSION AND CONCLUSIONS

The two sale areas are similar as regards the major tree species present but differ considerably in the level of root disease-caused mortality. The Ski-Overstory Sale Area is experiencing heavy losses due to root diseases primarily in unharvested white fir. Most of Block III contains white fir apparently released following the harvest of a Douglas-fir and ponderosa pine overstory. The stumps of these old-growth trees are probably the inoculum sources of *A. mellea* on the site. Although many of the Douglas-firs may have had latent infections on their roots prior to harvesting, they probably were not being killed by the pathogen. After trees are harvested, *A. mellea* can further colonize stumps of trees with latent infections and also invade previously uninfected stumps. The removal of the overstory allowed release and regeneration of white fir which is very susceptible to *A. mellea*.

In both sale areas, ponderosa pine appears to be infected more severely than white fir. In a survey done in the Bybee Creek Area, which is 4 mi. north of the Mistletoe and Ski Overstory Sale Areas, white fir was infected more heavily than ponderosa pine. The reasons for this discrepancy are not apparent, but whatever they may be, ponderosa pine as well as white fir should be discriminated against as a form of practical disease management in the Mistletoe and Ski Overstory Sale Areas.

MANAGEMENT ALTERNATIVES

The following management alternatives for disease reduction are presented for both the Mistletoe and Ski Overstory Sale Areas in increasing order of cost and effectiveness of reducing root disease:

(1) Defer treatment. If this course is followed, losses due to root disease-caused tree mortality probably will average 0.3 and 1.0 T/A/Yr. on the Mistletoe and Ski Overstory Sale Areas, respectively. This represents a loss of 140 and 172 BF/A/Yr., respectively, and does not include cull and growth loss in living, infected trees. Most of the loss will be in white fir and ponderosa pine.

(2) Sanitation-salvage logging. Much of the volume loss sustained above will be captured, especially in the Mistletoe Sale Area where losses are primarily in ponderosa pine. Losses after present salvage operations for the Mistletoe and Ski Overstory Sale Areas are 0.2 and 0.9 T/A/Yr. representing 16 and 98 BF/A/Yr., respectively. If this alternative is selected, the incidence of root disease may increase and the number of trees reaching merchantability will decrease with time.

(3) Seed tree or shelterwood systems favoring Douglas-fir or western white pine. Most of the merchantable timber will be harvested in one or a few operations. Future losses will decrease since white fir and ponderosa pine are most susceptible to Armillaria root rot. Losses may be decreased further if care is taken to mark leave trees that are low-risk to root disease, based on their proximity to infected trees or stumps.

(4) Clearcut or patchcut systems. All of the merchantable timber will be harvested at once. Any species besides ponderosa pine or white fir should be regenerated. Use a local seed source for planting stock. If white pine is regenerated, use blister rust-resistant stock. Sites may be hazard rated for blister rust to match tree susceptibility to hazard. FPM can provide this service. Although some root infection and mortality will occur as the new stand matures, it will be reduced greatly if white fir and ponderosa pine are discriminated against during regeneration and precommercial thinning.

(5) Clearcut, patchcut, or seed tree systems with stump removal. In addition to the benefits of alternatives 3 and 4, this alternative will be the most effective in reducing infection and mortality in leave trees and regeneration, including white fir and ponderosa pine, by removing the bulk of fungus inoculum from the soil. Stumps of infected trees are marked before cutting, and after harvesting, marked stumps are excavated with heavy machinery (Roth et al 1977). Topography of both sale areas should not hinder stump removal operations. FPM may be able to provide financial assistance if stump removal is chosen as the favored alternative. The Forest should request these funds on 3400-2; in addition, an environmental analysis report and cost/benefit evaluation must be made.

The information and recommendations presented in this report have been specifically formulated for the area we surveyed. Although some of this information may be applied to other areas in Oregon and Washington experiencing similar root disease problems, these areas may be sufficiently different from the area we surveyed to warrant a separate biological evaluation to formulate management alternatives specific to that area. FPM pathologists encourage and are available to perform such evaluations at the request of land managers.

REFERENCES CITED

Filip, G. M.
1980. Timber volume loss due to root disease in the Wagon Sale Area, Sisters Ranger District, Deschutes National Forest, Oregon. Forest Insect and Disease Management, Pacific Northwest Region, USDA Forest Service, Portland, Oregon. 30 pp.

Filip, G. M., B. M. Tkacz, and J. S. Worrell
1980. Disease survey of the Bybee Creek Area, Prospect Ranger District, Rogue River National Forest, Oregon. Forest Pest Management, Pacific Northwest Region, USDA Forest Service, Portland, Oregon. 12 pp.

Goheen, D. J.
1980. Root disease surveys of the Hyatt Lake Rehab and Howard Willow Sales, Medford District, Bureau of Land Management. Forest Insect and Disease Management, Pacific Northwest Region, USDA Forest Service, Portland, Oregon. 8 pp.

Roth, L. F., C. G. Shaw, III, and L. Rolph
1977. Combining commercial thinning of ponderosa pine and control of Armillaria root rot. J. For. 75:644-647.

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Table 1--Relative Frequencies of Trees by Species and Condition for the Ski Overstory Sale Area

Species		Total	Healthy[a]	Dead-Root Diseased				Dead Unknown			
				Unharvested	Harvested	Total		Unharvested	Harvested	Total	
White Fir	T/A	105.1	88.1	15.4	0.9	16.3	(15.5)[b]	0	0.7	0.7	(0.7)
	BA/A	59.3	40.0	12.8	3.6	16.4	(27.7)	0	2.9	2.9	(4.9)
	MCF/A	1.8	1.2	0.4	0.1	0.5	(27.7)	0	0.1	0.1	(6.4)
	MBF/A	8.6	5.3	1.7	0.9	2.6	(29.9)	0	0.7	0.7	(8.7)
Ponderosa Pine	T/A	0.7	0	0.4	0.3	0.7	(100)	0	0	0	
	BA/A	3.0	0	0.6	2.4	3.0	(100)	0	0	0	
	MCF/A	0.1	0	<0.1	0.1	0.1	(100)	0	0	0	
	MBF/A	0.7	0	0.1	0.6	0.7	(100)	0	0	0	
Douglas-fir	T/A	33.8	21.3	2.0	3.1	5.1	(15.1)	0	7.4	7.4	(21.9)
	BA/A	113.5	71.4	1.2	15.2	16.4	(14.5)	0	25.7	25.7	(22.7)
	MCF/A	4.6	3.0	<0.1	0.6	0.6	(13.7)	0	1.0	1.0	(21.3)
	MBF/A	29.2	19.0	0.2	3.9	4.1	(13.9)	0	6.1	6.1	(20.9)
White Pine	T/A	2.7	2.7	0	0	0		0	0	0	
	BA/A	5.7	5.7	0	0	0		0	0	0	
	MCF/A	0.2	0.2	0	0	0		0	0	0	
	MBF/A	1.3	1.3	0	0	0		0	0	0	
Total All Species	T/A	142.3	112.1	17.7	4.4	22.1	(15.5)	0	8.1	8.1	(5.7)
	BA/A	181.5	117.1	14.5	21.3	35.8	(19.7)	0	28.6	28.6	(15.8)
	MCF/A	6.7	4.4	0.4	0.8	1.2	(18.5)	0	1.1	1.1	(16.2)
	MBF/A	39.8	25.6	2.0	5.4	7.4	(18.5)	0	6.8	6.8	(17.2)

[a] No root collar infections.
[b] Number in parentheses is percent of total.

Table 2--Relative Frequencies of Root Pathogens by Tree Species and Pathogen for the Ski Overstory Sale Area

SPECIES		Total Root Diseased	*Armillaria mellea*	*Fomes annosus*	*P. weirii* and *A. mellea*	*A. mellea* and *F. annosus*
White Fir	T/A	16.3	15.6	0.3	0	0.4
	BA/A	16.4	14.6	1.2	0	0.6
	MCF/A	0.5	0.5	<0.1	0	<0.1
	MBF/A	2.6	2.2	0.3	0	0.1
Ponderosa Pine	T/A	0.7	0.7	0	0	0
	BA/A	3.0	3.0	0	0	0
	MCF/A	0.1	0.1	0	0	0
	MBF/A	0.7	0.7	0	0	0
Douglas-fir	T/A	5.1	4.7	0.1	0.1	0.2
	BA/A	16.4	14.0	0.6	0.6	1.2
	MCF/A	0.6	0.6	<0.1	<0.1	<0.1
	MBF/A	4.0	3.5	0.1	0.1	0.3
Total All Species	T/A	22.1	21.0 (95.0)[a]	0.4 (1.8)	0.1 (0.5)	0.6 (2.7)
	BA/A	35.8	31.6 (88.3)	1.8 (5.0)	0.6 (1.7)	1.8 (5.0)
	MCF/A	1.2	1.2 (87.9)	<0.1 (5.5)	<0.1 (1.7)	<0.1 (4.9)
	MBF/A	7.3	6.4 (87.3)	0.4 (5.9)	0.1 (1.8)	0.4 (5.0)

[a] Number in parentheses is percent of total.

Table 3--Relative Frequencies of Trees by Size Classes and Condition for the Ski Overstory Sale Area

DBH Class (in.)	Total	Healthy[a]	Dead-Root Diseased			Dead Unknown		
			Unharvested	Harvested	Total	Unharvested	Harvested	Total
	Trees per Acre							
4	32.8	32.8	0	0	0	0	0	0
8	39.5	32.7	6.8	0	6.8 (17.2)[b]	0	0	0
12	25.2	18.2	7.0	0	7.0 (27.8)	0	0	0
16	17.7	14.3	3.0	0.4	3.4 (19.2)	0	0	0
20	7.7	3.9	0.3	0.9	1.2 (15.6)	0	2.6	2.6 (33.8)
24	6.6	1.8	0.6	0.6	1.2 (18.2)	0	3.6	3.6 (54.5)
28	3.4	2.0	0	0.7	0.7 (20.6)	0	0.7	0.7 (20.6)
32	4.9	3.6	0	0.8	0.8 (16.3)	0	0.5	0.5 (10.2)
36	1.4	0.8	0	0.6	0.6 (42.9)	0	0	0
40	1.6	0.7	0	0.2	0.2 (12.5)	0	0.7	0.7 (43.8)
44	1.2	1.1	0	0.1	0.1 (8.3)	0	0	0
48	0.2	0.2	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0
60	0.1	0	0	0.1	0.1 (100)	0	0	0
Total all Classes	142.3	112.1	17.7	4.4	22.1 (15.5)	0	8.1	8.1 (5.7)

[a] No root collar infections.
[b] Number in parentheses is percent of total.

Table 4--Relative Frequencies of Trees by Species and Condition for the Mistletoe Sale Area

Species		Total	Healthy[a]	Dead-Root Diseased				Dead Unknown			
				Unharvested	Harvested	Total		Unharvested	Harvested	Total	
White Fir	T/A	123.4	114.3	1.2	0.7	1.9	(1.5)[b]	7.2	0	7.2	(5.8)
	BA/A	69.4	62.5	1.5	2.9	4.4	(6.3)	2.5	0	2.5	(3.6)
	MCF/A	2.1	2.0	<0.1	0.1	0.1	(7.5)	<0.1	0	<0.1	(1.0)
	MBF/A	10.0	9.1	0.2	0.7	0.9	(9.3)	<0.1	0	<0.1	(0.3)
Ponderosa Pine	T/A	36.1	23.6	1.9	1.1	3.0	(8.2)	7.1	2.4	9.5	(26.3)
	BA/A	38.9	20.0	1.5	7.4	8.9	(22.9)	2.5	7.5	10.0	(25.7)
	MCF/A	1.2	0.6	<0.1	0.3	0.3	(25.2)	<0.1	0.3	0.3	(22.9)
	MBF/A	6.3	2.8	0.1	1.8	1.9	(30.5)	<0.1	1.5	1.5	(24.7)
Douglas-fir	T/A	46.9	41.4	0	0.6	0.6	(1.3)	0	4.9	4.9	(10.4)
	BA/A	86.9	60.0	0	4.4	4.4	(5.1)	0	22.5	22.5	(25.9)
	MCF/A	3.2	2.1	0	0.2	0.2	(6.1)	0	0.9	0.9	(28.3)
	MBF/A	18.2	11.2	0	1.3	1.2	(7.0)	0	5.6	5.6	(31.0)
White Pine	T/A	3.4	0	0	0.2	0.2	(5.9)	3.2	0	3.2	(94.1)
	BA/A	3.2	0	0	0.7	0.7	(21.9)	2.5	0	2.5	(78.1)
	MCF/A	0.1	0	0	<0.1	<0.1	(27.6)	0.1	0	0.1	(72.4)
	MBF/A	0.5	0	0	0.2	0.2	(36.5)	0.3	0	0.3	(63.5)
Total All Species	T/A	209.8	179.3	3.1	2.6	5.7	(2.7)	17.5	7.3	24.8	(11.8)
	BA/A	198.4	142.5	3.0	15.4	18.4	(9.3)	7.5	30.0	37.5	(18.9)
	MCF/A	6.6	4.7	<0.1	0.6	0.6	(10.5)	0.1	1.2	1.3	(19.2)
	MBF/A	34.9	23.2	0.3	4.0	4.3	(12.3)	0.3	7.2	7.4	(21.5)

[a] No root collar infections.
[b] Number in parentheses is percent of total.

Table 5--Relative Frequencies of Root Pathogens by Tree Species and Pathogen for the Mistletoe Sale Area

SPECIES		Total Root Diseased	*Armillaria mellea*	*Fomes annosus*	*P. weirii* and *A. mellea*	*A. mellea* and *F. annosus*
White Fir	T/A	1.9	1.6	0	0.2	0.1
	BA/A	4.4	3.0	0	0.7	0.7
	MCF/A	0.1	0.1	0	<0.1	<0.1
	MBF/A	0.9	0.5	0	0.2	0.2
Ponderosa Pine	T/A	3.0	2.9	0.1	0	0
	BA/A	8.9	8.2	0.7	0	0
	MCF/A	0.3	0.3	<0.1	0	0
	MBF/A	1.9	1.8	0.1	0	0
Douglas-fir	T/A	0.6	0.6	0	0	0
	BA/A	4.4	4.4	0	0	0
	MCF/A	0.2	0.2	0	0	0
	MBF/A	1.3	1.3	0	0	0
White Pine	T/A	0.2	0.2	0	0	0
	BA/A	0.7	0.7	0	0	0
	MCF/A	<0.1	<0.1	0	0	0
	MBF/A	0.2	0.2	0	0	0
Total All Species	T/A	5.7	5.3 (92.9)[a]	0.1 (1.8)	0.2 (3.5)	0.1 (1.8)
	BA/A	18.4	16.3 (88.6)	0.7 (3.8)	0.7 (3.8)	0.7 (3.8)
	MCF/A	0.6	0.6 (87.6)	<0.1 (3.7)	<0.1 (4.7)	<0.1 (4.0)
	MBF/A	4.3	3.8 (87.6)	0.2 (3.7)	0.2 (4.5)	0.2 (4.2)

[a] Number in parentheses is percent of total.

Table 6--Relative Frequencies of Trees by Size Classes and Condition for the Mistletoe Sale Area

DBH Class (in.)	Total	Healthy[a]	Dead-Root Diseased			Dead Unknown		
			Unharvested	Harvested	Total	Unharvested	Harvested	Total
	Trees per Acre							
4	57.3	57.3	0	0	0	0	0	0
8	42.9	28.6	0	0	0	14.3	0	14.3 (33.3)
12	66.4	60.3	2.9	0	2.9 (4.4)[b]	3.2	0	3.2 (4.8)
16	14.3	14.3	0	0	0	0	0	0
20	12.7	9.2	0	0	0	0	3.5	3.5 (27.6)
24	6.8	5.6	0.2	0.2	0.4 (5.9)	0	0.8	0.8 (11.8)
28	2.5	1.8	0	0.7	0.7 (28.0)	0	0	0
32	4.3	0.9	0	1.2	1.2 (27.9)	0	2.2	2.2 (51.2)
36	0.5	0.4	0	0.1	0.1 (20.0)	0	0	0
40	1.7	0.9	0	0.2	0.2 (11.8)	0	0.6	0.6 (35.3)
44	0.3	0	0	0.1	0.1 (33.3)	0	0.2	0.2 (66.7)
48	0.1	0	0	0.1	0.1 (100.0)	0	0	0
Total	209.8	179.3	3.1	2.6	5.7 (2.7)	17.5	7.3	24.8 (11.8)

[a] No root collar infections.
[b] Number in parentheses is percent of total.

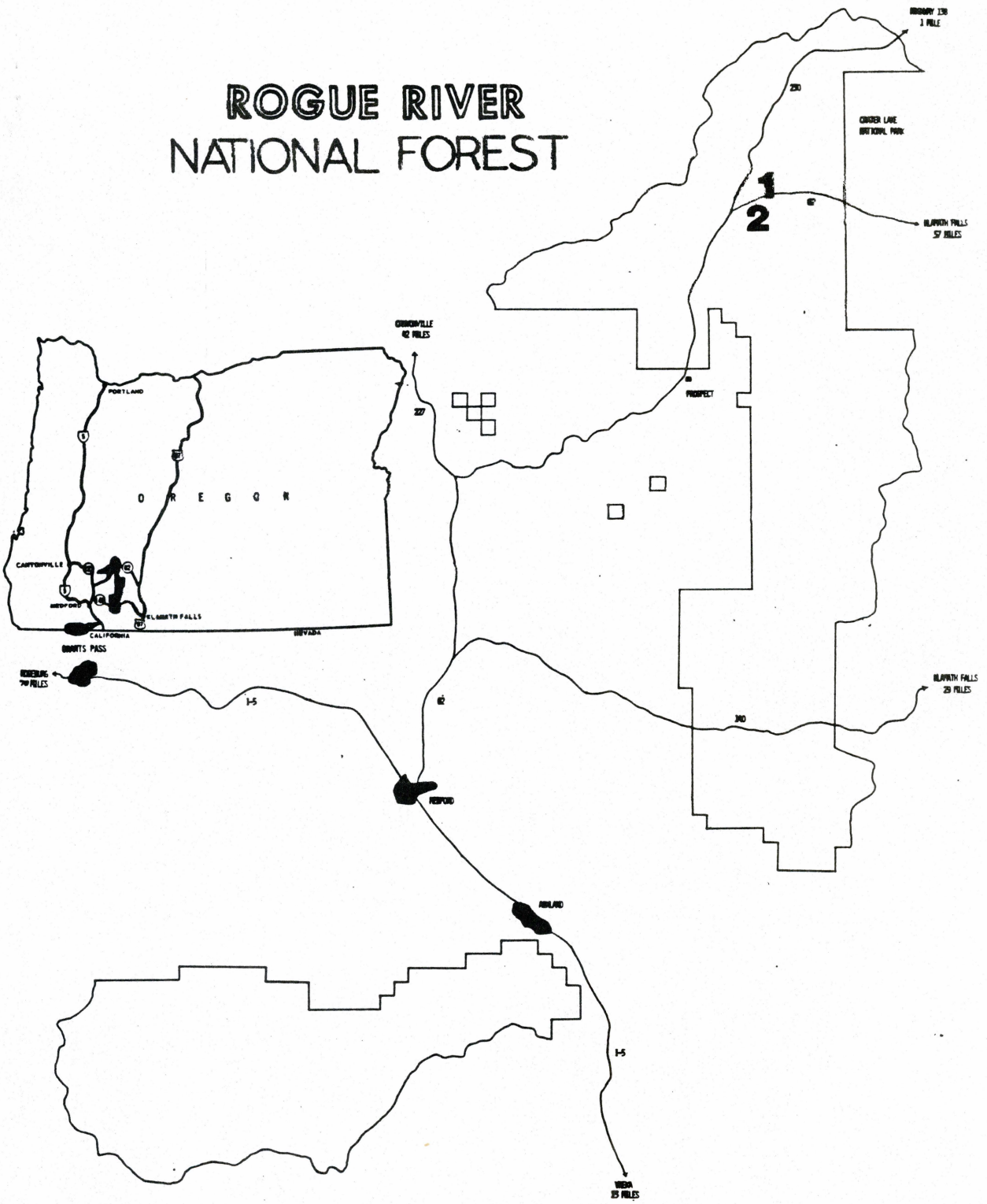

Figure 1

Map depicting location of Mistletoe (1) and Ski Overstory sale areas.

Figure 2--Mycelial fans of *Armillaria mellea* beneath the bark of an infected ponderosa pine.

Figure 3--White stringy decay caused by *Fomes annosus*.

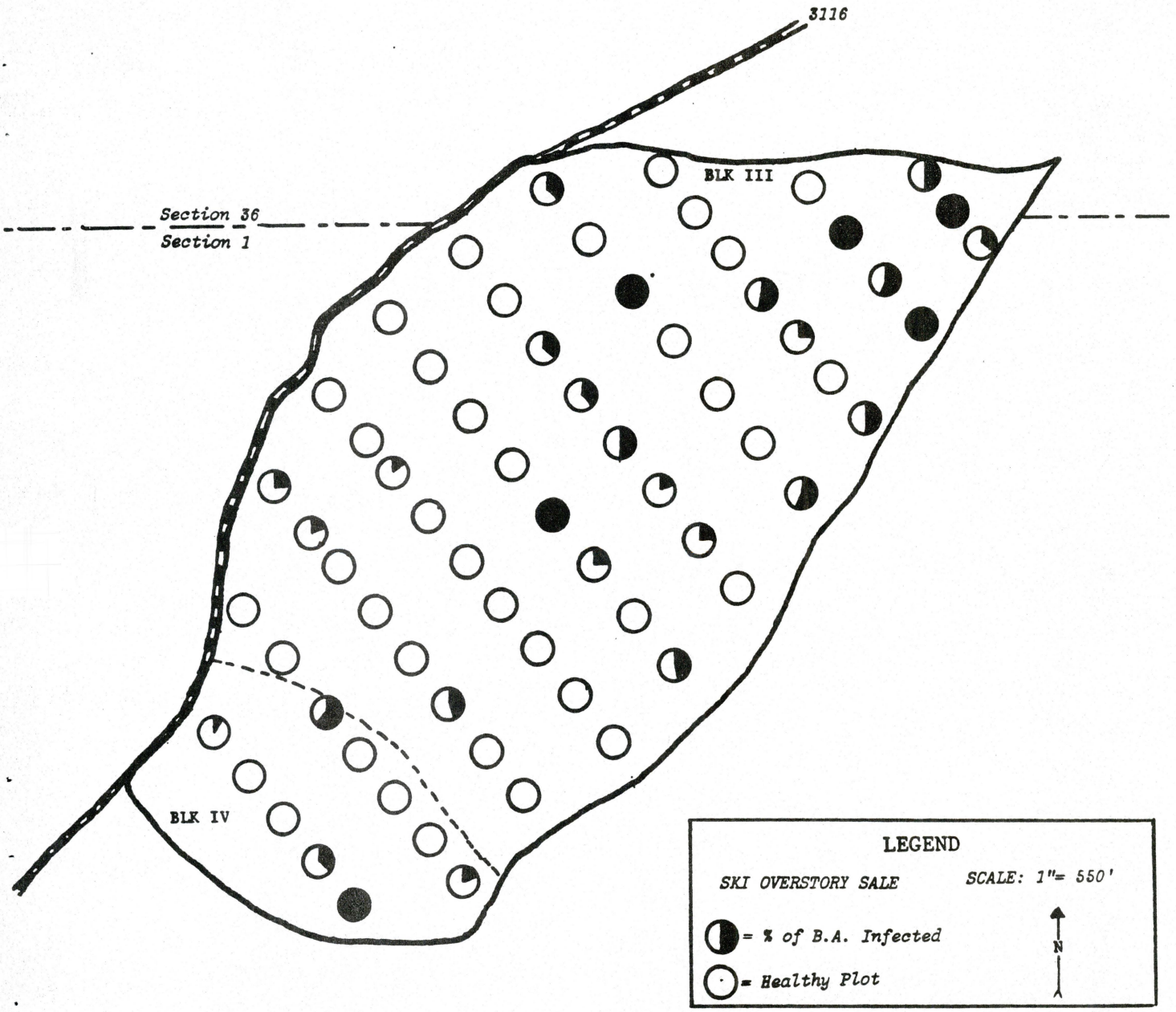
3116
BLK III
Section 36
Section 1
BLK IV
LEGEND
SKI OVERSTORY SALE
SCALE: 1"= 550'
= % of B.A. Infected
= Healthy Plot
N

Figure 4.

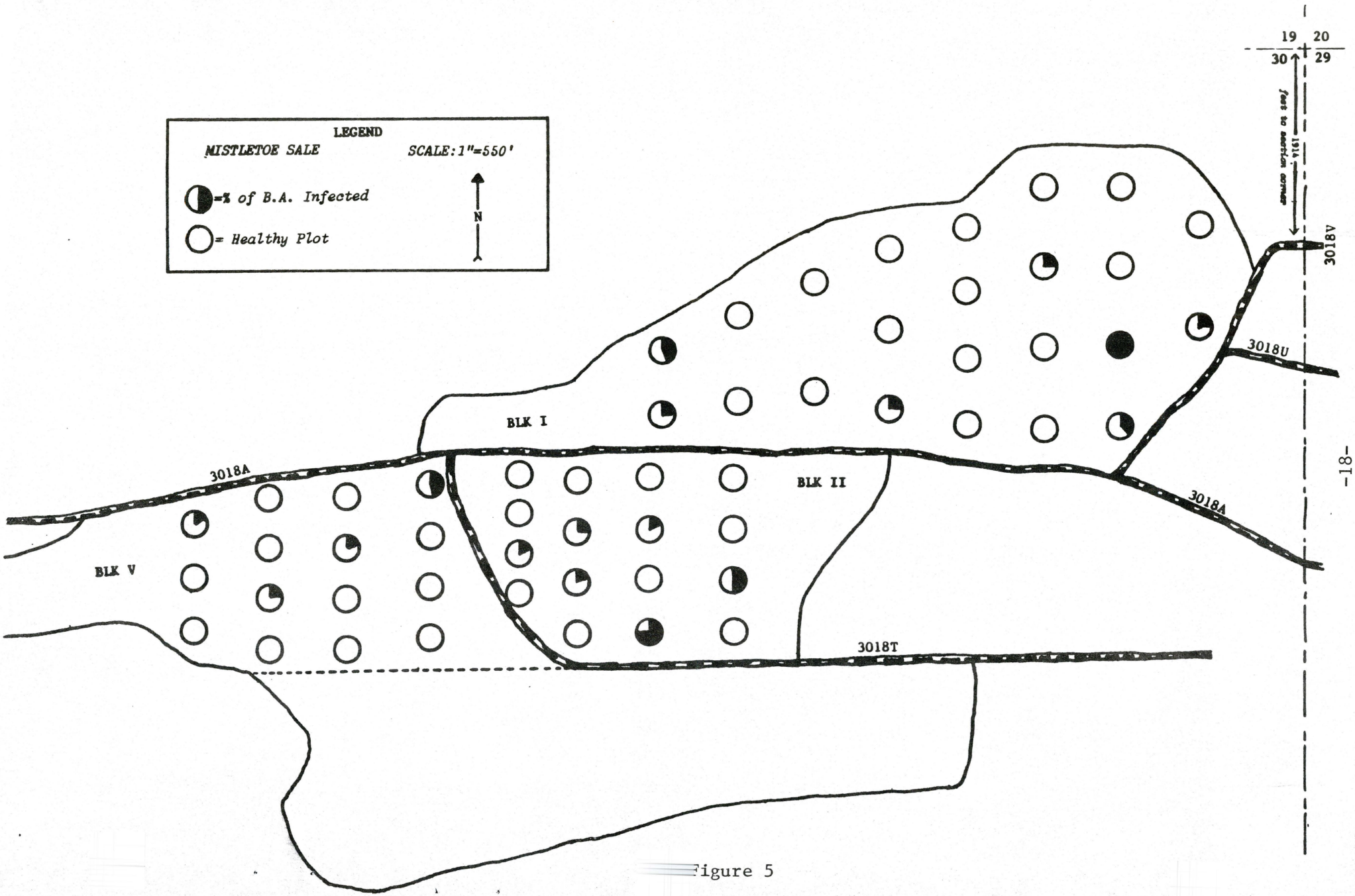
LEGEND
MISTLETOE SALE
SCALE:1"=550'
=% of B.A. Infected
= Healthy Plot
N
19
20
30
29
1914 feet to section corner
3018V
3018U
BLK I
3018A
BLK II
3018A
BLK V
3018T

Figure 5